Markets and Potential

An AB 549 Project Interim Report

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HMG Project #0304

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1. BACKGROUND

In the 2000-2001 Legislative Session, Assembly Member John Longville introduced a bill targeted at improving the energy efficiency of existing buildings. This bill (AB 549) requires the California Energy Commission (CEC) to conduct a study and provide recommendations for saving energy and reducing peak demand in existing residential and nonresidential buildings. These recommendations will be presented in a report to the Legislature.

In response to the AB 549 mandate, the CEC is developing an Action Plan Report for the Legislature. The Action Plan outline calls for a set of integrated strategies that will cost-effectively reduce peak and overall energy use in existing residential and nonresidential buildings in California. These strategies are likely to include both mandatory approaches such as new retrofit standards and voluntary strategies such as market-based programs to support better decision-making by consumers and contractors. Additionally, the Action Plan will identify any obstacles to and resource requirements for its implementation.

Southern California Edison, in cooperation with all of the Investor Owned Utilities (IOUs), including San Diego Gas & Electric, Southern California Gas Company, and Pacific Gas & Electric, is supporting the CEC's effort by providing research, analysis and recommendations on cost-effective, market-ready regulatory approaches and strategies to consider as part of the overall effort. The study, of which this report is a part, will characterize buildings, mechanisms and potential to guide decisions aimed at maximizing the cost-effective and practical expansion of regulatory strategies that can lead to improvement of the energy efficiency of existing buildings. In some cases, the recommendations that will ultimately emerge from this process will be ready to incorporate into a code revision. In other cases, the steps required before a strategy can be effectively adopted into code will be identified.

This preliminary report, Markets and Potential, characterizes the existing building market so as to identify potential areas of opportunity. It helps to create a framework for further study of mandatory approaches in existing buildings markets.

The second report, Events and Measures, will provide a set of recommended strategies for mandatory approaches to improving energy efficiency in buildings. The third report, the Final Project Report, will summarize the recommendations and will include statewide savings estimates.

2. CHARACTERISTICS OF THE EXISTING BUILDING MARKET

To quantify potential energy savings, certain market characteristics must be defined. In this report, we look at the basic characteristics of the residential and nonresidential markets. As specific strategies and their potential regulatory measures and mechanisms are defined, market-specific data will be gathered to estimate the potential savings likely to result from the adoption of such a strategy.

2.1 Residential Sector

To assess the energy savings potential in the residential sector, the details of the current and historic building stock and market must be understood. In this section, we present:

- Types of residences and their share of the market
- Ages of residences and their share of the market
- Frequency of residential real estate transactions
- Average household energy expenditures

2.1.1 Types of Residences

Tables 1 and 2 detail the types of residential buildings in California and total number of dwelling units those buildings represent. Unit type in Table 1 is based on ownership and building type. The majority are single-family units occupied by the owner. In Table 2, the number of units is based on structure. Single-family units dominate the market.

Type and Ownership of Housing Units in California, Million of Households

	Total Units
Single-Family Detached	6.5
Single-Family Attached	1.3
Multi-Family (2-4 units)	0.5
Multi-Family (5 or more units)	2.7
Mobile Home	0.5
Total Housing Units	**11.5**

* U.S. Dept. Of Energy, Energy Information Administration, Housing Characteristics 1997

Table 1: Type and Ownership of Housing Units

Types of Housing Units in California, Based on Structure		
	Total Units	% of Total
1-unit, detached	6,883,493	56.4%
1-unit, attached	931,873	7.6%
2 units	327,024	2.7%
3 to 4 units	697,779	5.7%
5 to 9 units	722,827	5.9%
10 to 19 units	619,092	5.1%
20 or more units	1,462,793	12.0%
Mobile home	538,423	4.4%
Boat, RV, van, etc	31,245	0.3%
Total Housing Units	**12,214,549**	**100%**

* U.S. Bureau of the Census, Census 2000

Table 2: Types of Housing Units, Based on Structure

Table 3 lists the housing tenure of occupied housing units. The majority of homes in California are owner-occupied (56.9%). The renter-occupied market presents unique issues such as split benefits to occupant/owner and must be looked at differently. Even though they're not the majority, renter occupied units constitute a significant portion of the market.

Housing Occupancy in California		
	Number	% of Total
Owner-occupied housing units	6,546,334	56.9%
Renter-occupied housing units	4,956,536	43.1%
Total occupied housing units	**11,502,870**	**100%**

* U.S. Bureau of the Census, Census 2000

Table 3: Number of Residential Units Owned Versus Rented

2.1.2 Age of Residences

In Table 4, we examine the housing stock based on when the unit was built. Residences were grouped into four timeframes:

- Units built prior to 1982
- Units built between 1982 and 1991
- Units built between 1992 and 2000
- Units built after 2000

These timeframes were based on major stringency increases of the Building Energy Efficiency Standards for residential buildings. Before 1982, there were very few residential energy requirements. The years 1982, 1992, and 2001 represented major stringency increases in the Standards, leading to more energy efficient units built during those years. Table 4 shows that the majority of

buildings, regardless of type, were built prior to 1982. The prevalence of older buildings is further illustrated in Figure 1 for single-family homes.

Residential Building Stock

	Single-Family Dwelling Units		Multifamily Buildings	
	Units Added	Total Units	Units Added	Total Units
pre-1982		5,554,290		2,723,422
1982-1991	1,080,354	6,634,644	610,900	3,334,322
1992-2000	720,714	7,355,358	216,720	3,551,042
2001-current	193,220	7,548,578	73,577	3,624,619

Source: California Energy Commission, 2003 Forecast Data for Residential Buildings.

Table 4: Residential Building Stock in California

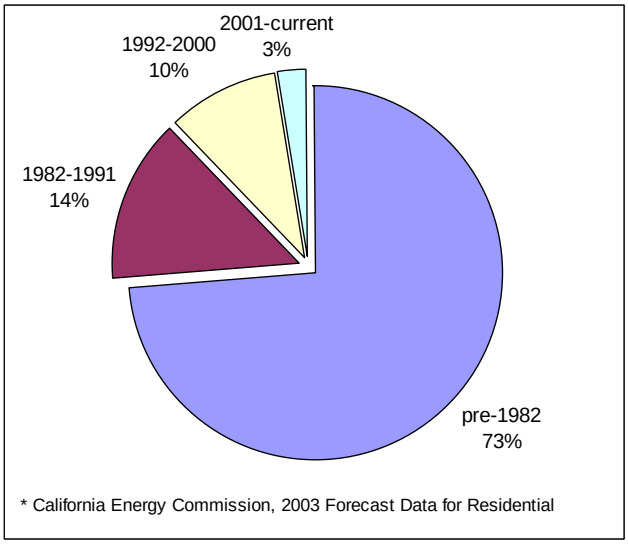


Figure 1: Percentage of Single-Family Dwelling Units Built in California by Vintage

As homes age, features within a home are upgraded, appliances are replaced and remodels are planned and built. These events impact the efficiency of a home. We will discuss the impact of these events further in Section 3.

2.1.3 Residential Resale Market

Home resale is a trigger event that could be utilized to create a change in the efficiency of the existing residential market. Table 5 shows the number of dwelling units sold and the total floor area those sales represent. The data is shown by time groupings that correspond with standards efficiency stringency levels. Similar to the building stock, the residential resale market is dominated by homes built prior to 1982. These pre-1982 homes were built before any significant strides were made in residential energy standards. Figure 2 shows that the percentage of older homes in the resale market remained relatively

constant. It also shows that the volume of turnover in the residential market is significant. Therefore, one of the most opportune times to improve the energy efficiency of older homes is at the time of sale. Appendix A provides detailed resale data.

Residential Building Resales from 1993-2002

Single-Family Dwelling Units

Year Built	Number of Units	Total Area (10^6 Sq.Ft.)
pre-1982	2,181,865	3,312.8
1982-1991	573,497	1,103.1
1992-2000	210,012	433.5
2001-current	1,871	4.9
Total	2,967,245	4,854.3

Multifamily Dwelling Units

Year Built	Number of Units	Total Area (10^6 Sq.Ft.)
pre-1982	181,348	756.5
1982-1991	12,853	144.9
1992-2000	3,274	13.4
2001-current	37	0.1
Total	197,512	914.8

Condominiums

Year Built	Number of Units	Total Area (10^6 Sq.Ft.)
pre-1982	345,648	416.1
1982-1991	254,137	329.7
1992-2000	49,658	71.0
2001-current	420	0.7
Total	649,863	817.4

* Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 5: Residential Resales in California from 1993 -2002

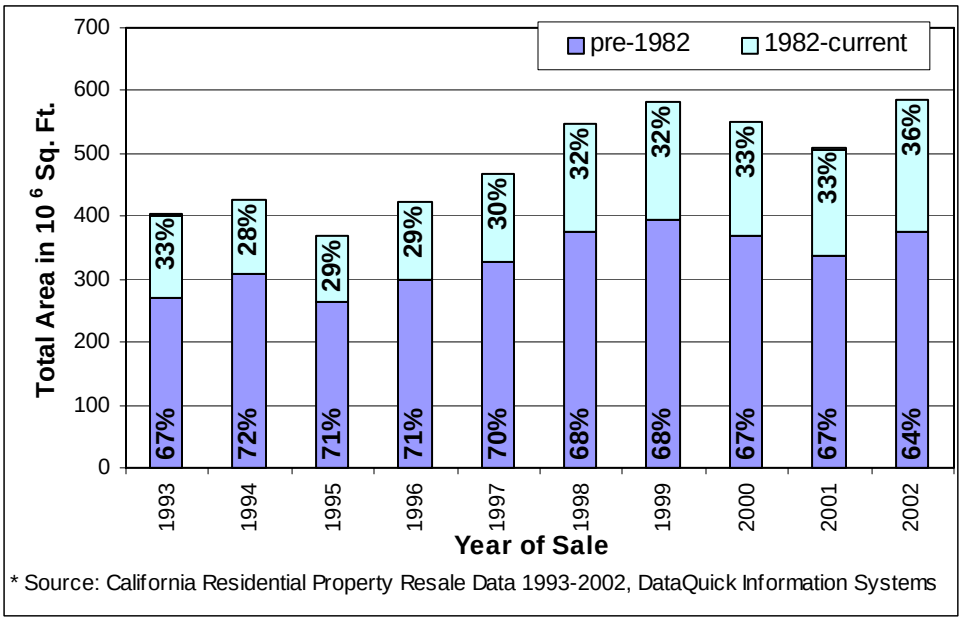


Figure 2: Single-Family Dwelling Resale Area By Year in California

Figure 3 looks at the resale data from the past ten years to determine the trend of building size. Single-family dwelling units have increased in area since 1982.

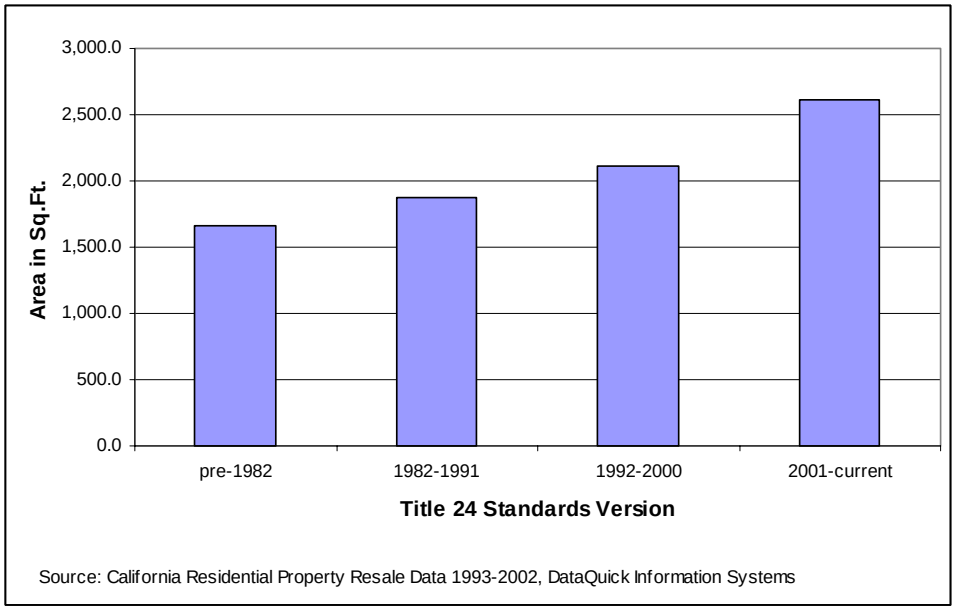


Figure 3: Increase in Average Area of California Residential Buildings

The frequency of real estate transactions is another important consideration for the potential trigger of a home sale as an opportunity for energy efficiency improvements. The high frequency of occupants changing residences is further shown in Table 6. The 2000 U.S. census revealed that more than half of the respondents (53%) had moved into their present unit within the past five years.

Year Householder Moved Into Unit For California		
	Number of Households	% of Total
1 year ago	2,456,426	21.4%
2 to 5 years ago	3,630,521	31.6%
6 to 10 years ago	1,842,387	16.0%
11 to 20 years ago	1,752,425	15.2%
21 to 30 years ago	1,023,528	8.9%
Over 30 years ago	797,583	6.9%
Occupied Housing Units	**11,502,870**	**100%**

* U.S. Bureau of the Census, Census 2000

Table 6: Year California Householders Moved into Present Unit

2.1.4 Residential Energy Usage

In 1997, the average California household spent $1009 on energy.[1] Table 7 shows the average national household energy expenditure by age of home, shown in five-year increments. Older buildings typically carry a higher energy cost per square foot. However, most older homes are significantly smaller than today's homes, and most newer homes have a larger saturation of appliances so the per household cost for energy of homes has not changed significantly by vintage.

1997 Household Energy Expenditures, by Vintage ($ per Sq. Ft)				
Year	Per Household		Per Square Foot	
Prior to 1980	$	1,408	$	0.88
1980 to 1986	$	1,312	$	0.80
1987 to 1989	$	1,491	$	0.77
1990 to 1995	$	1,453	$	0.70
1996 to 1997	$	1,324	$	0.62
Average	$	1,403	$	0.82

2002 Bldgs Energy Databook, US DOE Office of Energy Efficiency and Renewable Energy

Table 7: National Average Household Energy Expenditures Valuated in Dollars per Sq. Ft.

Table 8 shows who pays the energy bills in rental properties. Occupants are overwhelmingly the primary party responsible for energy costs. Where landlords are responsible for the utility bill, there is more incentive to make improvements to the building since they will directly benefit from any reduction in energy costs. In the case where the tenant pays the utility bills, the owner will have less

[1] U.S. Dept. Of Energy, Energy Information Administration, Residential Energy Consumption Survey 1997

incentive for making improvements to the building. If the tenant makes the improvement, assuming they can obtain permission to alter the building, they will not benefit from any increase in equity. Furthermore, it is uncertain that the tenant will remain in the building long enough to recoup the cost of their investment through the energy savings. This split incentive is a barrier to energy efficiency improvements in rental property.

Party Responsible for Electricity and Gas Among Rented Occupied Units

	Landlord	Occupant	Don't Know	Sample Size
Electricity Costs	3%	97%	0%	494
Gas Costs	11%	88%	1%	456

* RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report. 2000

Table 8: Who Pays Electric and Gas Costs in California's Residential Rental Units

2.1.5 Residential Market Conclusions

The residential market is dominated by older homes. Five and a half million homes were built prior to the first substantial residential version of the Building Energy Efficiency Standards, resulting in a wide disparity of energy efficient construction standards between newly constructed homes and existing homes. Although utility programs and codes impact the efficiency of residences during remodels or additions, there is still a large untapped energy savings potential. Considering the prevalence of older homes in the resale market and the frequency of residential real estate transactions, utilizing time of sale as a trigger mechanism for upgrades warrants further research.

2.2 Commercial Sector

To assess the energy savings potential in the commercial sector, we researched the current and historic building stock and market. This section presents:

- Types of commercial buildings and their share of the market
- Ages of commercial buildings and their share of the market
- Frequency of commercial real estate transactions
- Ownership characteristics of buildings

2.2.1 Types of Commercial Buildings

The commercial sector is often divided by occupancy type. Figure 4 provides the percentage of each occupancy type relative to the total nonresidential floor area. The largest occupancy types by floor area are large offices (17%), retail (16%), and non-refrigerated warehouses (13%). The other category listed in Figure 4

consists of occupancy types where each type is less than 1% of the total floor area for all commercial buildings.

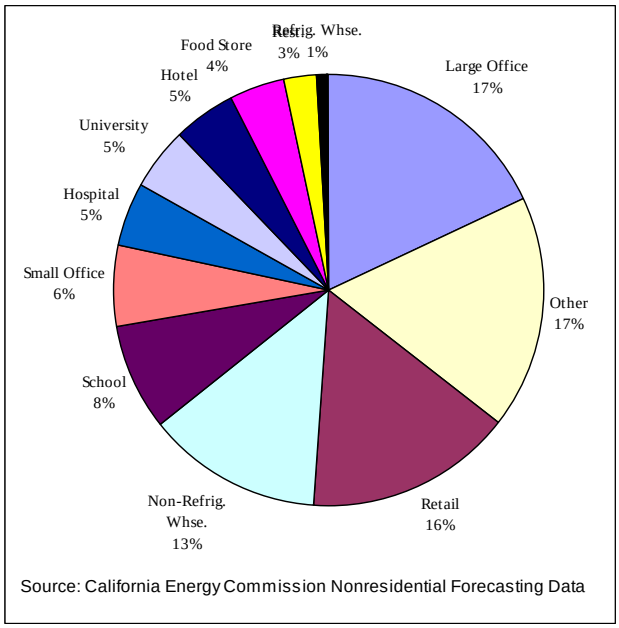


Figure 4: Percent of 2002 California Nonresidential Floor Area by Occupancy Type

Table 9 provides the average floor area for nonresidential buildings by occupancy type. The occupancy types are slightly different than described in the building stock, but provide similar results as Figure 4.

Average Floor Area of Nonresidential Buildings By Occupancy Type

Bldg Type	Average SqFt
C&I Storage	227,619
General C&I Work	82,435
Office	78,165
Retail and Wholesale Store	70,313
Medical/Clinical	68,282
Theater	62,843
Fire/Police/Jails	49,852
Grocery Store	49,758
School	42,946
Libraries	38,234
Community Center	35,992
Other	34,704
Gymnasium	32,716
Religious Worship, Auditorium, Convention	25,065
Hotels/Motels	17,667
Restaurant	11,529

Source: 1999 Nonresidential New Construction Baseline Study for the California Energy Commission and 1999-2002 Building Energy Assessment (BEA) Study for Southern California Edison. RLW Analytics

Table 9: Average Floor Area of California Nonresidential Buildings by Occupancy Type

2.2.2 Age of Commercial Buildings

In this section, we examine the commercial floor stock area based on when the unit was built. Buildings were grouped into four timeframes:

- Units built prior to 1978
- Units built between 1978 and 1991
- Units built between 1992 and 2000
- Units built after 2000

These timeframes were based on major stringency increases in the Building Energy Efficiency Standards for commercial buildings. The Building Energy Efficiency Standards was established in 1978 in response to a legislative mandate to reduce California's energy consumption. The years 1978, 1992 and 2001 represented major stringency increases in the nonresidential Standards. Figure 5 illustrates the portion of building floor space constructed during each timeframe as a percentage of all nonresidential building stock that existed in 2002. The predominant category is floor space built prior to 1978.

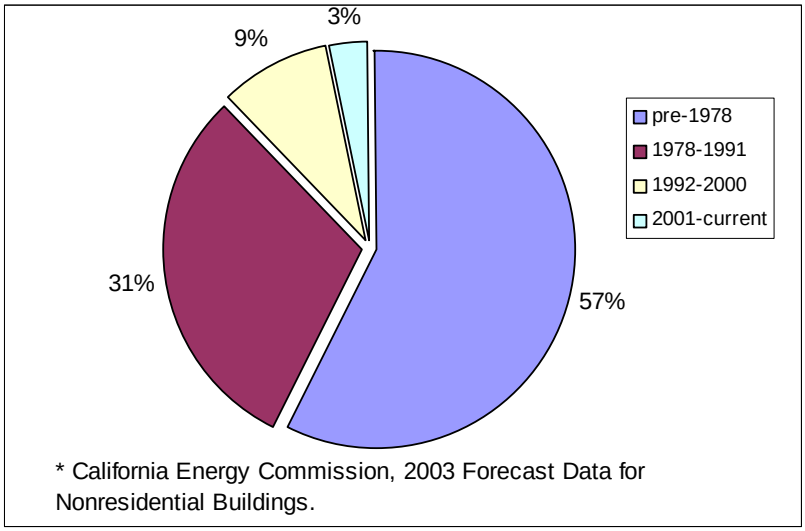


Figure 5: Breakdown of 2002 California Nonresidential Floor Stock Areas

In Table 10 and Table 11, nonresidential floor stock area is shown by occupancy type and vintage. For all occupancy types, buildings built prior to 1978 constitute more than half of the current building stock. For educational buildings (school and university), two-thirds of the current building stock was built prior to 1978.

Nonresidential Floor Stock Area in 10^6 Sq.Ft.													
Year	Small Office	Restaurant	Retail	Food Store	Non-Refrigerated Warehouse	Refrigerated Warehouse	Schools	University	Hospital	Hotel	Other	Large Office	Total
pre-1978	181	91	500	135	368	23	357	198	150	139	597	512	3,251
1978-1991	136	42	277	68	287	12	40	45	84	108	271	415	1,784
1992-2000	158	55	373	92	364	20	84	71	123	120	378	487	2,326
2001-current	167	59	398	98	394	22	96	79	131	130	410	522	2,505

* California Energy Commission, 2003 Forecast Data for Nonresidential Buildings.

Table 10: Nonresidential Floor Stock Area by Occupancy Type

Percent of Nonresidential Floor Stock Area (10^6Sq.Ft.) Built Prior to 1978

Year	pre-1978	Current Stock	% of Stock
Small Office	191.4	347.7	55%
Restaurant	94.3	149.5	63%
Retail	519.8	897.5	58%
Food Store	140.3	233.4	60%
Non-Refrigerated Warehouse	383.2	762.3	50%
Refrigerated Warehouse	23.8	45.2	53%
School	361.4	453.0	80%
University	201.3	277.1	73%
Hospital	153.3	280.5	55%
Hotel	140.9	269.0	52%
Other	610.5	1,007.7	61%
Large Office	523.1	1,033.3	51%
Total	**3,343.4**	**5,756.2**	**58%**

* California Energy Commission, 2003 Forecast Data for Nonresidential Buildings.

Table 11: Percent of California Nonresidential Floor Area Built Prior to 1978 By Occupancy Type

2.2.3 Commercial Resale Market

The characteristics of commercial building sales provide significant information to assist us in determining whether the trigger event of sale may be viable for commercial buildings. In Table 12, the total amount of floor space sold from 1993-2002 is given. The data is displayed according to building vintage. Similar to the building stock, the nonresidential resale market is dominated by buildings constructed prior to 1978, before the nonresidential Building Energy Efficiency Standards were enacted. The prevalence of older commercial buildings involved in real estate transactions is further illustrated in Figure 6. In the past ten years, the majority of commercial building floor area sold in California was built prior to 1978. However, unlike the residential market, the percentage of older floor area in the resale market was more variable. Despite the variability, the trigger event of the sale of a building remains an effective opportunity to reach older buildings.

Commerical Resale Area in 10^6 Sq.Ft.

	1993-2002	% of Total
pre-1978	371.7	58%
1978-1991	236.8	37%
1992-2000	28.7	5%
2001-current	0.1	0%
Total	**637.4**	**1.0**

Source: California Commercial Property Resale Data 1993-2002, DataQuick Information Systems

Table 12: Commercial Floor Area Resold in California from 1993-2002

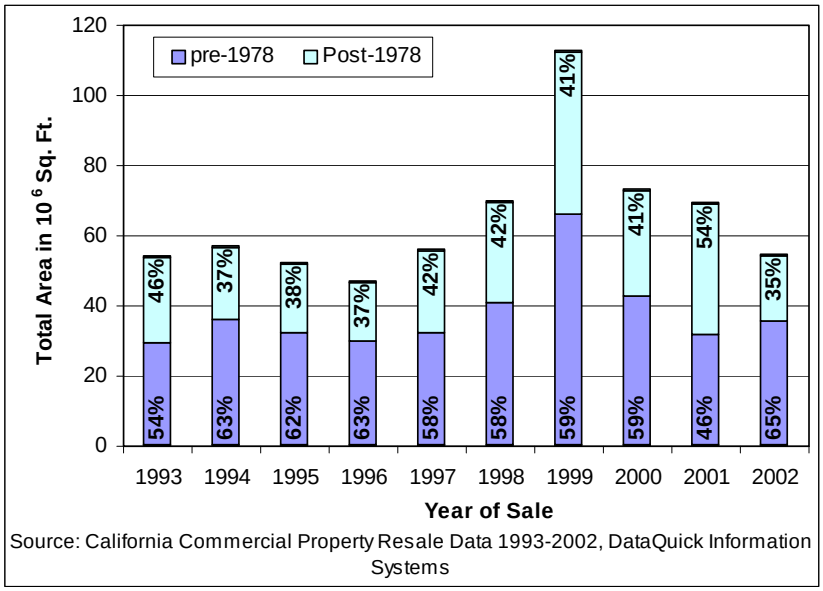


Figure 6: Commercial Floor Area Resold in California by Year

2.2.4 Ownership Characteristics

Table 13 lists the ownership types of commercial buildings from the 1999 Commercial Buildings Energy Consumption Survey by the U.S. Dept. of Energy's Energy Information Administration. The majority of floor area is owner-occupied (56.1%).

Ownership Types of U.S. Commercial Floor Area

	Total Floorspace (10^6 Sq. Ft.)	% of Total
Publicly-owned	12,343	18.3%
Owner-occupied	37,785	56.1%
Nonowner-occupied	15,596	23.2%
Unoccupied	1,613	2.4%
Total floorspace	**67,337**	**100%**

* U.S. Dept. of Energy, Energy Information Administration, 1999 Commercial Buildings Energy Consumption Survey: Building Characteristics Tables

Table 13: Ownership Types of U.S. Commercial Floor Area

While the majority of commercial buildings are owned, many buildings are leased. Standard lease rates vary by occupancy types.[2] For office spaces, the standard lease is for a five-year period. For industrial space, the standard lease is for a ten-year period. Retail spaces have the shortest timeframe for a lease, typically three to five years.

[2] Conversation with Grubb & Ellis Research Department

2.2.5 Commercial Sector Assessment

The commercial market is dominated by older buildings, regardless of building type. Three billion square feet of nonresidential floor space was built before the California Nonresidential Standards existed. Since no overall energy standard governed construction practice, and since common construction practice at the time did not typically address energy efficiency, it can be assumed that the energy characteristics in older buildings are substandard when compared to today's common practice. Although utility programs and codes provide incremental improvements in the efficiency of many of these older buildings, there is still a large untapped energy savings potential.

3. SAVINGS POTENTIAL IN THE EXISTING BUILDINGS MARKET

In this section, we explore the potential energy savings in the existing building market. The distribution of energy end use, possible building lifetime events, and trigger mechanisms are provided.

In California, between 70% and 80% of commercial and residential buildings were constructed before building standards took effect. The existing building stock represents a substantial opportunity for additional energy savings, especially in comparison to newly constructed buildings. Figure 7 is a concept drawing that illustrates the energy efficiency gap between newer buildings and older ones. The gap represents the improvement potential of an effective building retrofit program. Influenced by the Building Energy Efficiency Standards, new construction has the greatest energy efficiency increase over time, while the existing stock has the lowest. Existing stock still slightly improves over time due to two factors. One, appliances are replaced with substantially more efficient ones due to the influence of Appliance Efficiency Standards and utility retrofit programs. Two, new construction in year one becomes existing stock in year two. Over time, the average efficiency of existing stock increases slightly. The ”current efficiency of all buildings” line in the figure represents the total stock, new and existing. However, because the existing stock is considerably greater in volume than new construction, the current efficiency of all buildings falls close to the efficiency of the existing stock. Since there is so much existing stock volume, if we assume a large incidence and penetration of trigger events, any action taken during those events will have substantial benefits. It’s possible that over time, under optimum conditions, the existing market can approach the level of efficiency of the new construction market, as shown in the shaded area labeled “potential efficiency of all buildings”.

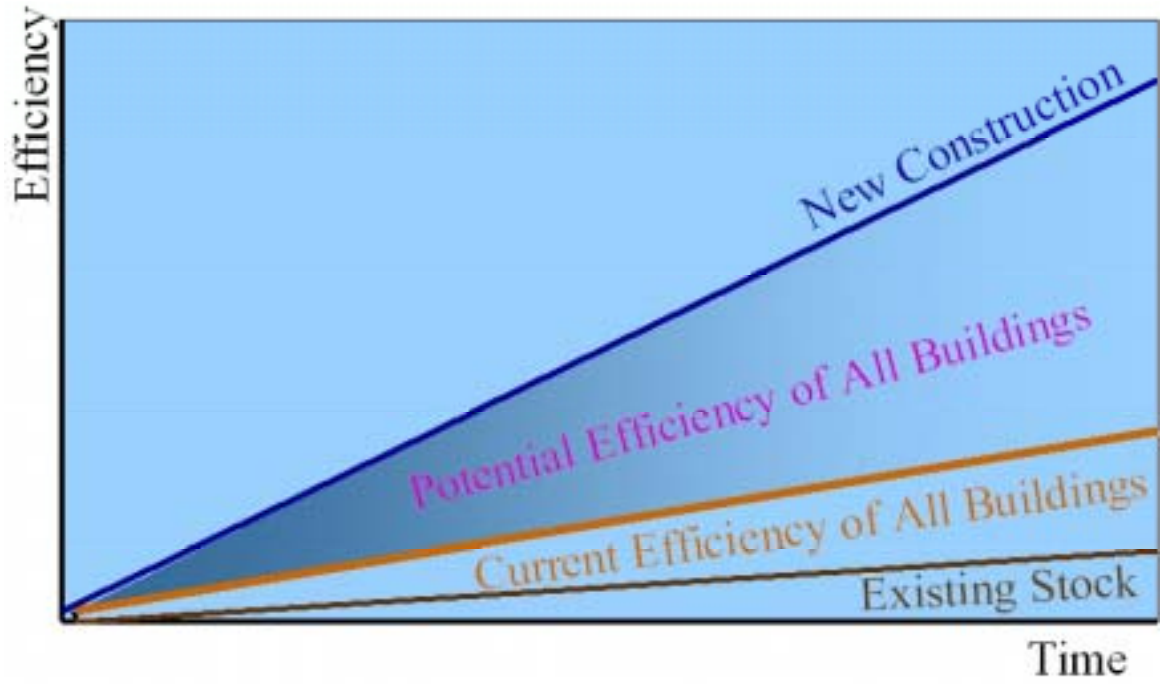
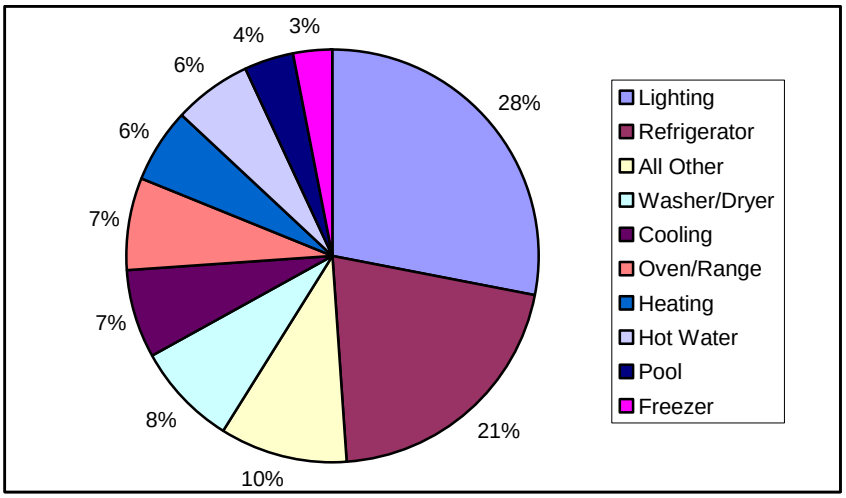


Figure 7: Efficiency Potential of Buildings - Concept Drawing

Since buildings typically have a life of 50-90 years, updating the energy efficiency of these buildings is a sound investment. As a buildings progress through their natural life, certain upgrade opportunities present themselves. For example, older appliances may be replaced with more energy efficient ones. The local utility may sponsor a program to provide incentives to increase insulation levels. The HVAC unit may be tuned up during the course of a repair. When building owners or decision makers choose to take advantage of these kinds of opportunities, the buildings' energy efficiency increases relative to buildings of the same vintage and occupancy. If building owners do nothing, the buildings' energy use gradually increases, due to system and envelope degradation.

3.1 Residential Sector

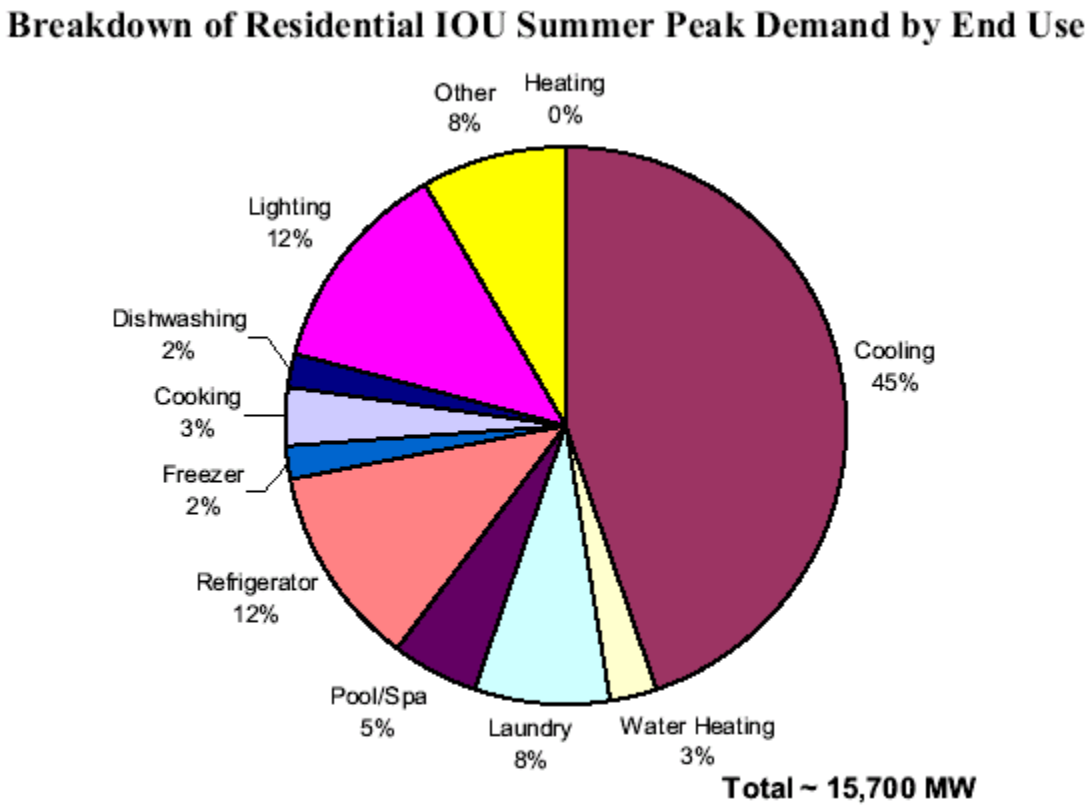
In order to determine the savings potential in the residential sector, the distribution of household energy end use must be understood. Targeting large end uses, which could be impacted by frequent trigger events, will provide the greatest energy savings. Figure 8 shows the percentage of total residential electricity use for common electrical end uses. Lighting and refrigeration account for the largest portions at 28% and 21% respectively. While household lighting efficiency could be easily improved by replacement of lamps with more efficient lamps, refrigeration efficiency is unlikely to change unless the unit changes.



Heschong Mahone Group, Lighting and Efficiency Technology Report, Volume I: California Baseline 1997

Figure 8: Residential Electrical Use, By End Use, California 1992

Another important consideration is the distribution of household energy end use during summer peak demand. Figure 9 provides a breakdown of summer peak demand by end use for residential customers of investor-owned utilities. Cooling (45%) accounts for the largest portion.

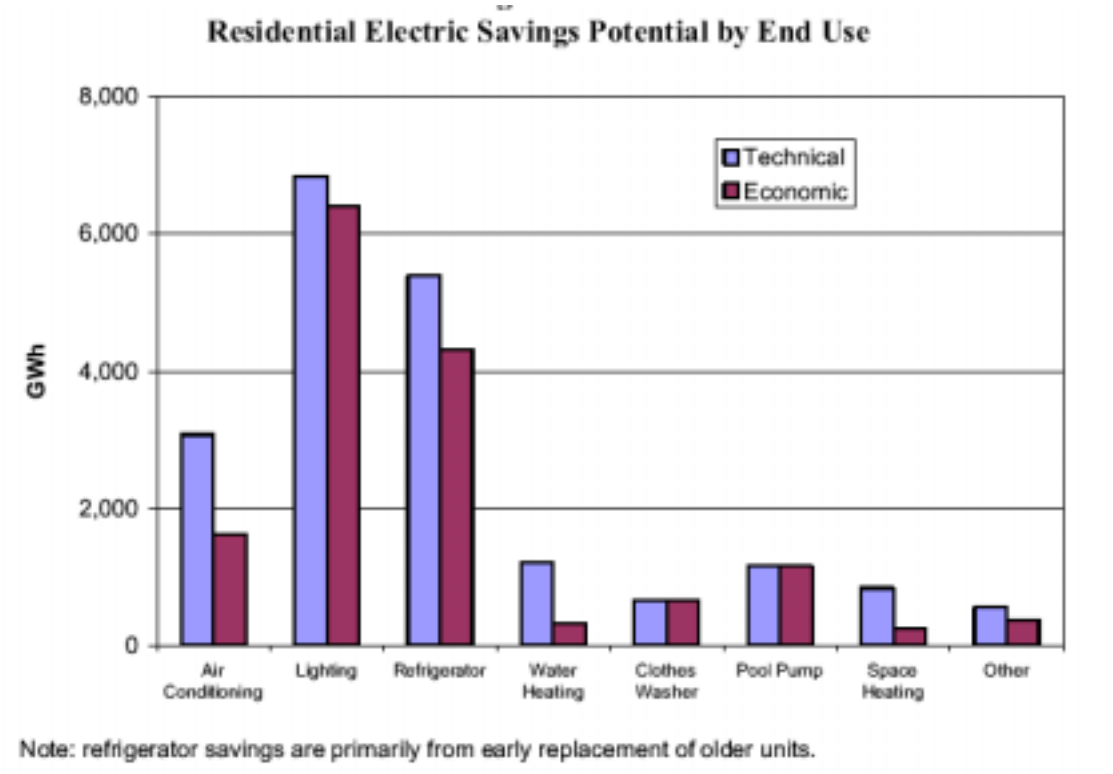


Source: KEMA-XENERGY. Residential Sector Energy Efficiency Potential Study

Figure 9: Residential IOU Summer Peak Demand by End Use

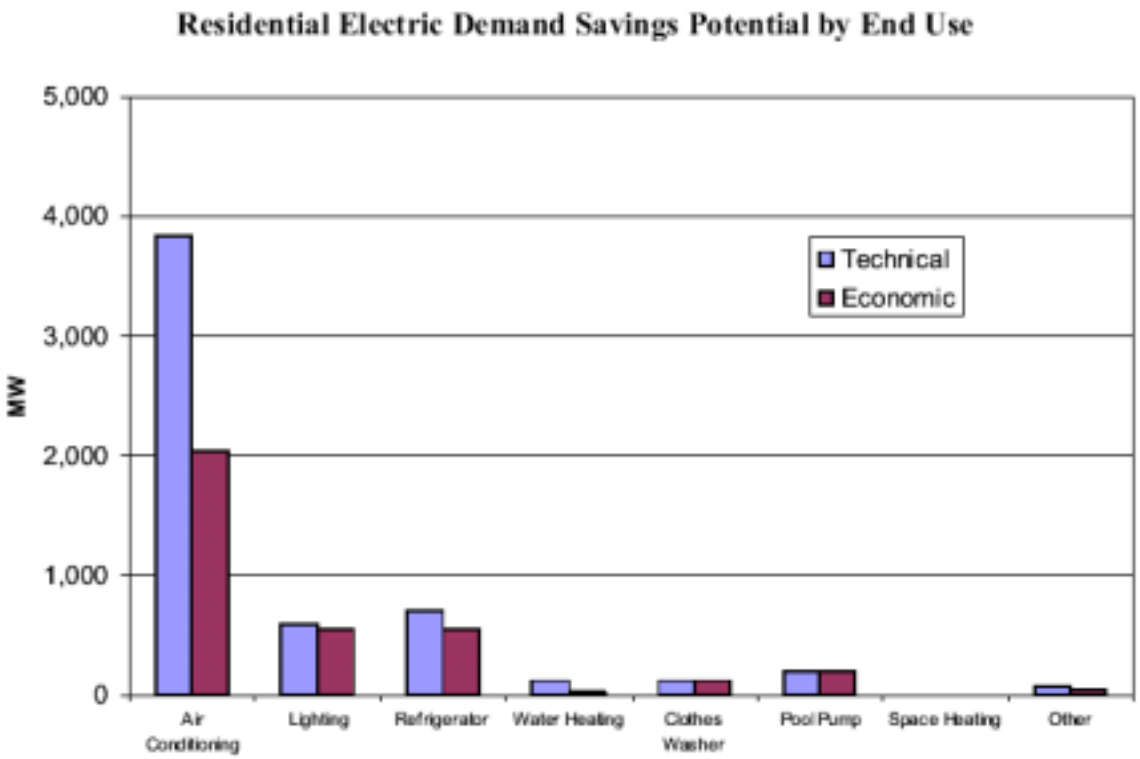
The *California Statewide Residential Sector Energy Efficiency Potential Study*, prepared by KEMA-Xenergy, Inc. for PG&E and the California IOUs, focuses on assessing technical and economic energy-efficiency potential in the residential sector[3]. Technical potential refers to the amount of energy savings or peak demand reduction that would occur with the complete penetration of all measures analyzed in applications where they are deemed technically feasible from an engineering perspective. Economic potential refers to the technical potential of energy-efficient measures that are cost effective when compared to either supply side alternatives or the price of energy. Economic potential takes into account that many energy-efficient measures cost more to purchase initially than their standard efficiency counterparts cost. Figure 10 and Figure 11 illustrate the results concluded in the study.

[3] California Statewide Residential Sector Energy Efficiency Potential Study, Pacific Gas and Electric Company April 2003, Rufo, M. and Coito, F., KEMA-Xenergy, Inc.



Source: KEMA-XENERGY. Residential Sector Energy Efficiency Potential Study

Figure 10: Residential Electric Savings Potential in California by End Use



Source: KEMA-XENERGY. Residential Sector Energy Efficiency Potential Study

Figure 11: Residential Electric Demand Savings Potential in California by End Use

The following tables represent saturation statistics for lighting and cooling systems. These systems were chosen because of their large potential for annual energy savings and peak demand reduction, respectively. Table 14 presents the distribution of the number of fixtures per home. Approximately 6% of homes have more than 40 fixtures. Table 15 shows the percentage of lamps by type. The predominant lamp type is incandescent. Compact fluorescent lamps account for only 16% of total fixtures.

Distribution of Number of Fixtures

Number of Fixtures	% of Homes (n=1255)
1-10	22.7%
11-20	42.7%
21-30	19.9%
31-40	8.6%
41-50	3.0%
>50	3.1%

RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report 2000

Table 14: Distribution of Number of Fixtures per California Home

Percentage Lamp Types	
Lamp Type	% of Total Lamps (n=1255)
Compact Fluorescent	1%
Flourescent	15%
Halogen	3%
Incandescent	81%

RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report 2000

Table 15: Percentage of Lamp Types

Table 16 shows a breakdown of classes of primary cooling systems. Central split system air conditioners predominate.

Breakdown of Classes of Primary Cooling Systems		
Equipment Type	Central	Space
Evaporative System	1%	6%
Packaged System AC	17%	0%
Split System AC	56%	0%
Window/Wall Room Air Conditioner	0%	21%

RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report 2000

Table 16: Types of Primary Cooling Systems

Table 17 shows the average estimated age of primary cooling systems. The average central air conditioner system is twelve years old, with an average estimated life expectancy of thirteen years.[4] This indicates that many units will be replaced in the upcoming years.

[4] RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report. 2000.

Average Age of Primary Cooling Systems		
	Equipment Type	Average Age
Central	All Types	12.3
	Packaged System AC	14.9
	Split System AC	11.7
	Evaporative System	10.8
Space	All Types	13
	Evaporative System	13
	Window/Wall Room	13

RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report 2000

Table 17: Average Age of Primary Cooling Equipment

Table 18 shows the saturation of central air conditioners statewide, shown by utility. Figure 12 provides the saturation of central air conditioning in homes built during the construction vintage groupings represented by Title 24. The proportion of residences with central air conditioning has steadily increased in the past 25 years across all utilities.

2002 Central A/C Saturation Grouped by Utitilities	
PG&E	28%
SMUD	69%
SCE	43%
LADWP*	26%
SDG&E	32%
BGP*	40%
All Utilities	40%

*Does not include mobile homes

California Energy Commission, 2003 Forecast Data for Residential Buildings

Table 18: Central A/C Saturation by Title 24 Standards Version Per Utility

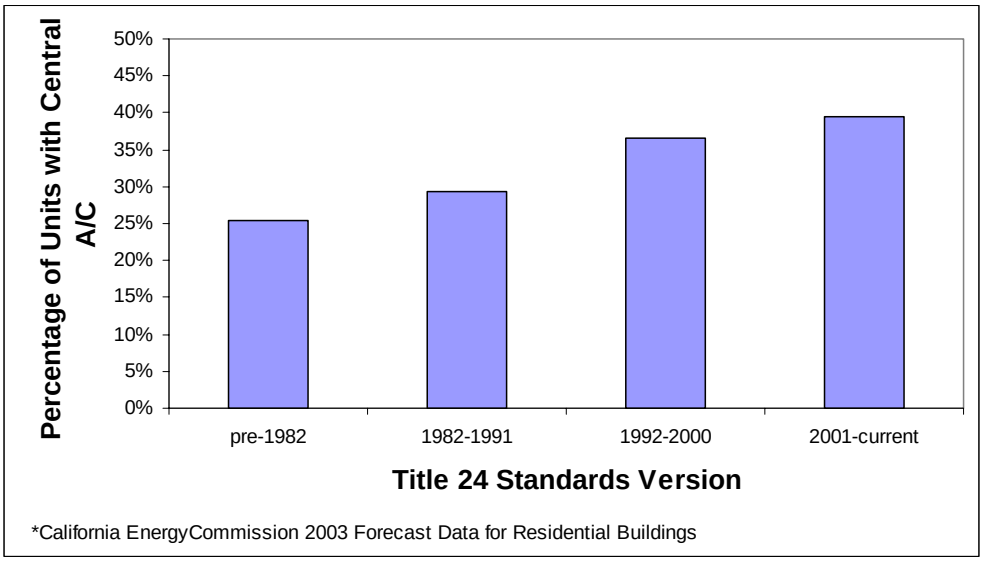


Figure 12: Central A/C Saturation Grouped by Title 24 Standards Version

In Table 19, the distribution of primary cooling systems by seasonal energy efficiency ratio (SEER) is given. SEER is a measure of air conditioner efficiency given in kBtu of cooling delivered per kWh of electrical energy consumed. Most cooling systems are below the 11 SEER range.

Distribution of Cooling Systems by SEER

SEER Range	Central Packaged	Central Split
13 or higher	0.4%	2.2%
12 to 12.99	0.4%	7.3%
11 to 11.99	0.7%	7.3%
10 to 10.99	3.7%	26.4%
9 to 9.99	2.2%	18.3%
8 to 8.99	1.1%	26.7%
Less than 8	0.0%	3.3%

RLW Analytics, Inc. California Statewide Lighting and Appliance Saturation Study Final Report 2000

Table 19: Distribution of Primary Cooling Systems By SEER

In Table 20, the possible lifetime events during the Title 24 standard version of a residential building are given. Common time periods for appliance replacement and sale of a home were used.

Residential Building Lifetime Events.								
Event	1978-1981	1982-1985	1986-1987	1988-1991	1992-1994	1995-1997	1998-2000	2001-2002
House is sold	SALE	SALE			SALE		SALE	
HVAC is replaced	HVAC			HVAC				
Roof is replaced	ROOF				ROOF			
Water heater is replaced	DHW				DHW			
Refrigerator is replaced	REFR				REFR			
Clothes washer is replaced	WASH			WASH				
Clothes dryer is replaced	DRY			DRY				
Dishwasher is replaced	DISH			DISH			DISH	
Windows are replaced	WIND			WIND			WIND	

Table 20: Residential Building Lifetime Events

Figure 13 is an illustration of the conceptual lifetime of a building. The efficiency of the building is compared to the efficiency of new construction. The arrows for each lifetime event represent a potential improvement in energy savings.

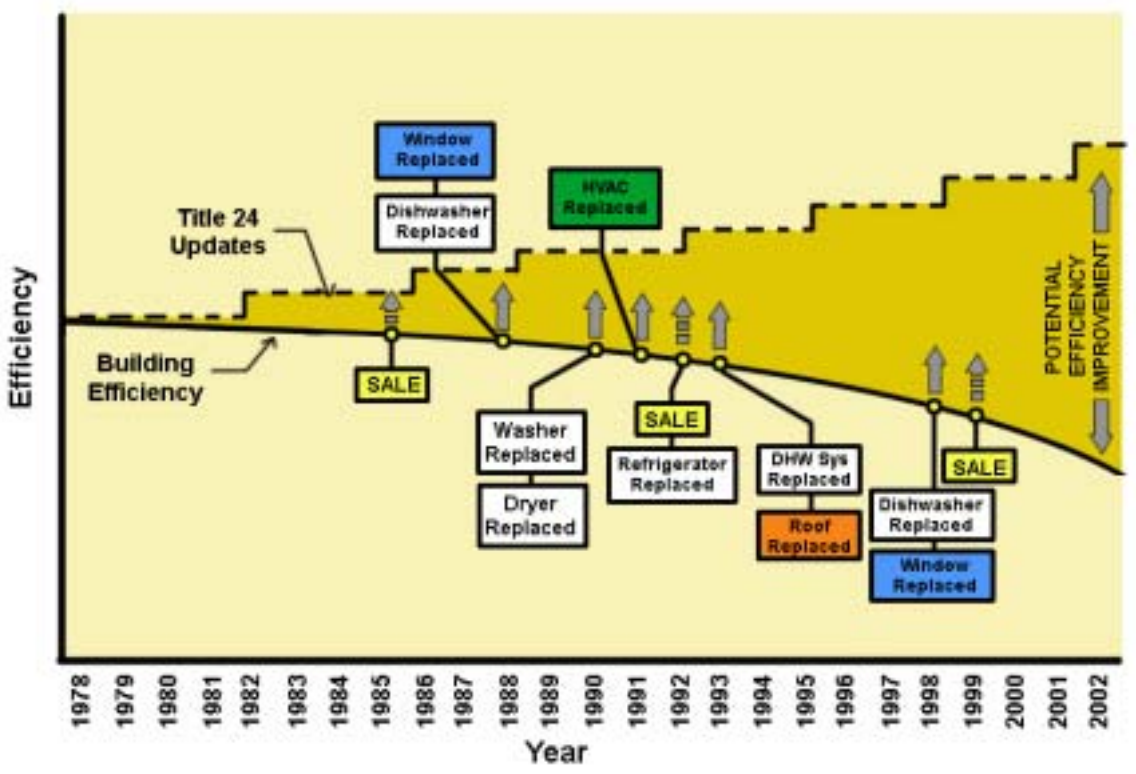


Figure 13: Residential Building Lifetime and Events Concept Drawing

Trigger events signal an opportunity to increase energy efficiency in a building. Trigger events for residences may include Equipment Replacement, Equipment Repair, Remodel, Sale or other change in occupant, Utility Energy Audit**,** Utility Bill Update or Inquiry. Current mechanisms have an effect during many of these triggers. Expanding the scope or authority of these mechanisms could provide a way to increase efficiency in these buildings. These topics will be explored in the next project report, "Events and Measures."

3.2 Commercial Sector

Figure 14 shows the percentage of total commercial sector energy use by specific end uses. Interior lighting and heating account for the largest energy end uses.

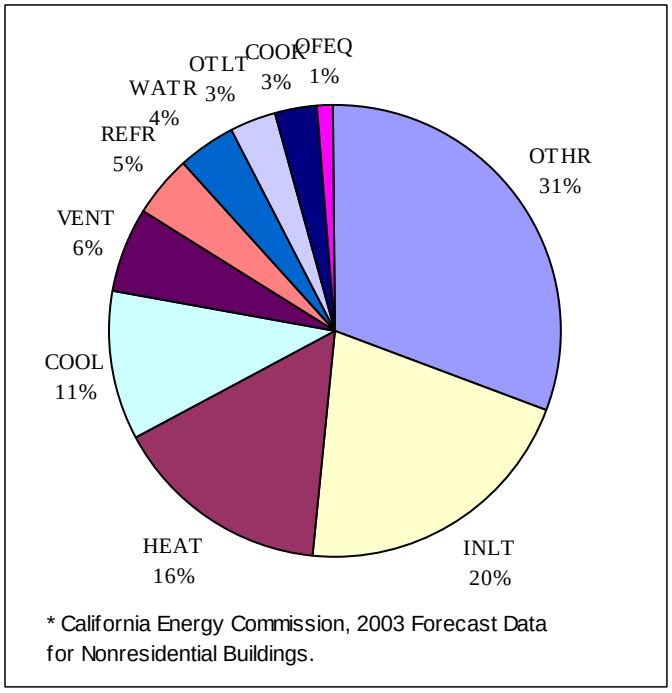


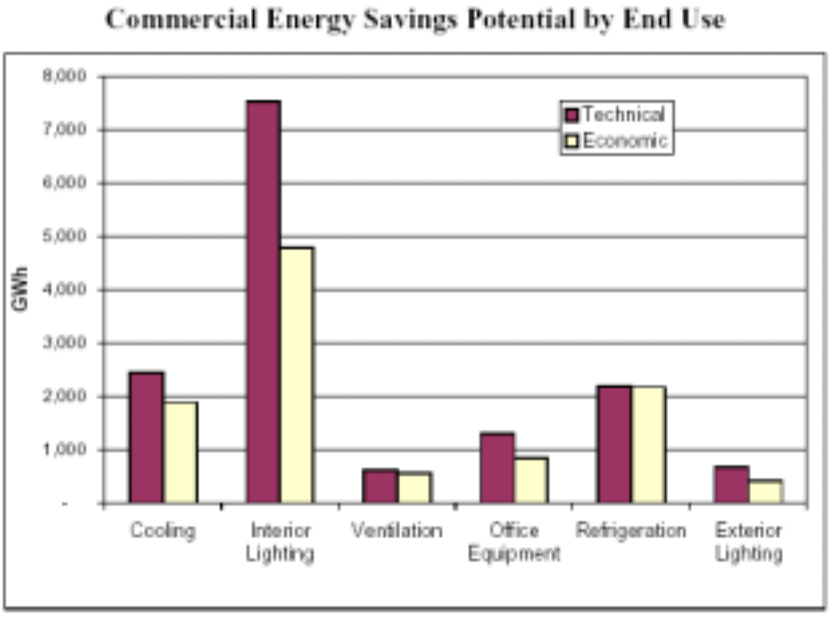
Figure 14: Commercial Energy End Use for 2002

The *California Statewide Commercial Sector Energy Efficiency Potential Study*, prepared by KEMA-XENERGY, Inc. for PG&E and the California IOUs, focuses on assessing electric energy-efficiency potential in the commercial sector[5]. Analysis was completed in similar manner as the *California Statewide Residential Sector Energy Efficiency Potential Study.* It was done in part to help focus the IOU incentive money in the most appropriate ways. For our purposes, the study quantifies the energy savings potential and provides a list of measures that

[5] California Statewide Commercial Sector Energy Efficiency Potential Study Pacific Gas and Electric Company July 2002, Rufo, M and Coito, F Xenergy

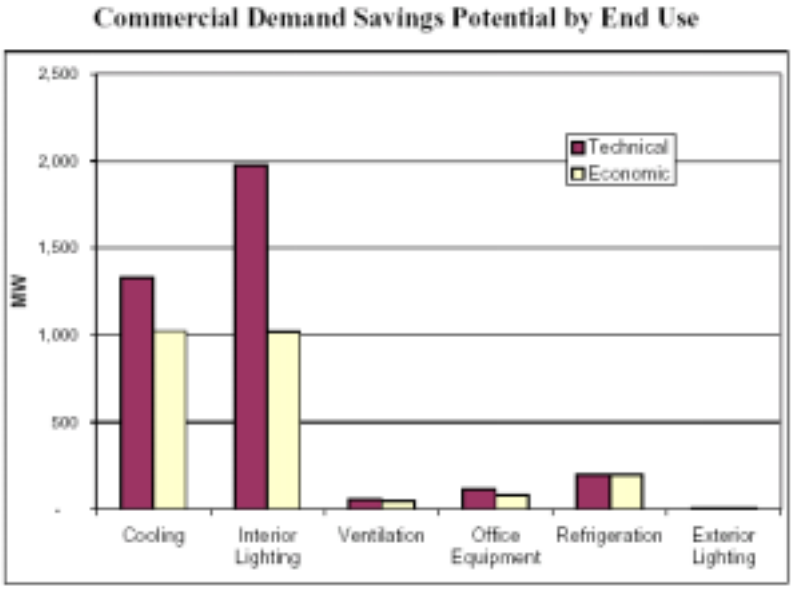
represent the best opportunities for capturing that potential. Figure 15 and Figure 16 summarize the results.

The study found that, despite the significant adoption of high-efficiency lighting throughout the 1990s, interior lighting still represents the largest end-use savings potential in absolute terms for both energy and peak demand. As expected, cooling potential represents a significant portion of the total peak demand savings potential. Refrigeration energy savings potential is roughly equal to that of cooling but is significantly less important in terms of peak demand potential.



Source: KEMA-XENERGY. Commercial Sector Energy Efficiency Potential Study

Figure 15: Commercial Energy Savings Potential by End Use



Source: KEMA-XENERGY. Commercial Sector Energy Efficiency Potential Study

Figure 16: Commercial Demand Savings Potential by End Use

Significant potential was identified for lighting controls systems such as occupancy sensors (12,100 GWh and 290 MW) and dimming systems (1,700 GWh and 770 MW). The study authors estimate that 10% of the potential savings has already been captured due to saturation.

The study also identified the prevalence of low-efficiency HVAC package units as a major lost opportunity. If standards were increased by 6 percent, an additional 30 GWh per year (17 MW) of saving could occur. A portion of this savings could be captured by a code change.

In Table 20, the possible lifetime events of a commercial building are given. Common time periods for appliance replacement and lease periods are used.

Commercial Building Lifetime Events.

Event	1978-1981	1982-1985	1986-1987	1988-1991	1992-1994	1995-1997	1998-2000	2001-2002
Building is leased	LEASE	LEASE		LEASE	LEASE		LEASE	
AC is replaced	AC				AC			
Bioler is replaced	BOIL						BOIL	
Cooling Tower/Evap Cooler is replaced	COOL				COOL			
Furnace is replaced	HEAT						HEAT	
Heat pump is replaced	PUMP				PUMP			
Roof is replaced	ROOF				ROOF			
Water heater is replaced	DHW				DHW			
Lighting is replaced	LIGHT	LIGHT			LIGHT		LIGHT	
Lighting controls are replaced	CONTROL		CONTROL		CONTROL			
Windows are replaced	WIND			WIND			WIND	

Table 21: Commercial Building Lifetime Events

Figure 17 is an illustration of the conceptual lifetime of a building and the events that may occur during its life. As with the residential building, the efficiency of the commercial building is compared to the efficiency of new construction with potential improvements in energy efficiency for each event.

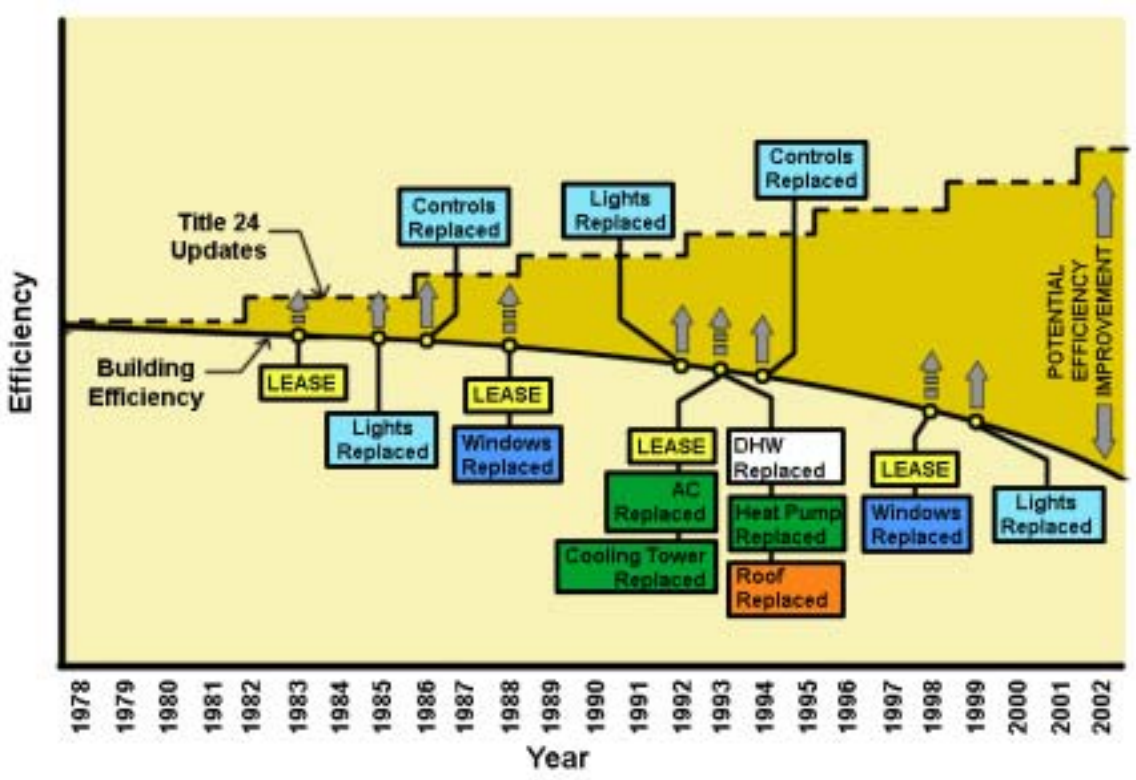


Figure 17: Commercial Building Lifetime and Events Conceptual Drawing

4. NEXT STEPS

This report is one of three prepared to provide the IOU contribution toward the AB 549 effort. The conclusions of this report are:

1. The majority of existing building stock pre-dates the Building Energy Efficiency Standards.

2. The energy efficiency improvement potential is significant.

3. Mechanisms that impact the existing building markets are already in place. Any improvement to those mechanisms should be supported.

4. The potential energy savings from this market justifies further research into expansion of authority, capitalization of potential trigger events and other strategies to bring about an improvement to the existing buildings stock.

The next interim report for this project, Events and Measures, will provide a set of recommended strategies for mandatory approaches to improving energy efficiency in existing buildings markets. The report will detail key events in the life of an existing building that are opportunities for energy efficiency improvements, provide a list of promising energy efficiency measures, and research potential mandatory mechanisms that could be used to enact those measures.

5. APPENDIX A – DETAILED TABLES FOR EXISTING MARKETS CHARACTERISTCS

Tenure Choices of Recent Movers, 2001

Thousands of Households

Previous Tenure	Own			Rent			Percent of Current Owners That Moved Within Previous Year	Percent of Moving Owners That Became Renters
Current Tenure	Own	Rent	All	Own	Rent	All		
Total	4,783	2,315	7,098	5,028	11,172	16,200	13.6	32.6
Age								
Under Age 35	1,068	808	1,877	2,554	6,625	9,179	35.2	43.1
35-44	1,448	606	2,055	1,342	2,312	3,654	17.1	29.5
45-54	982	442	1,424	660	1,230	1,891	9.9	31.1
55-64	705	202	907	308	518	827	8.8	22.3
65 and Over	579	256	835	163	486	649	4.2	30.7
Family Type								
Married without Children	1,551	292	1,844	1,236	1,232	2,468	10.9	15.9
Married with Children	1,751	327	2,078	1,624	1,931	3,556	17.3	15.7
Single Parent	260	402	662	555	2,188	2,743	19.4	60.8
Other Family	243	135	378	252	631	883	10	35.6
Single Person	786	972	1,759	966	3,520	4,486	11.4	55.3
Other Nonfamily	191	186	378	395	1,669	2,064	23.2	49.3
Metropolitan Status								
Center City	856	858	1,713	1,347	5,066	6,413	13.6	50.1
Suburban	2,727	982	3,709	2,684	4,311	6,995	14.2	26.5
Non-Metropolitan	1,200	475	1,675	997	1,795	2,792	12.2	28.4
Marital Status								
Married, Spouse Present	3,302	619	3,922	2,860	3,163	6,024	13.6	15.8
Married, Spouse Absent	64	80	144	67	254	321	13	55.6
Widowed	337	214	551	136	416	552	5.2	38.8
Divorced	711	643	1,353	792	1,900	2,692	15.9	47.5
Separated	58	205	263	109	598	707	16.2	78
Never Married	311	554	865	1,063	4,841	5,904	21.1	64
Stated Reasons for Moving								
All reasons of equal importance	102	39	141	119	170	289	na	27.4
Private company or person wanted to use it	10	10	20	29	211	239	na	49.5
Forced to leave by the government	18	0	18	7	40	47	na	0
Disaster loss (fire, flood, etc.)	15	19	34	16	57	73	na	56.6
New job or job transfer	497	303	799	292	1,313	1,606	na	37.9
To be closer to work/school/other	269	170	440	178	1,120	1,298	na	38.7
Other, financial/employment related	73	87	160	78	375	453	na	54.5
To establish own household	135	156	291	833	717	1,550	na	53.8
Needed a larger house or apartment	866	57	922	433	1,359	1,791	na	6.1
Married, widowed, divorced, or separated	296	370	666	113	316	429	na	55.5
Other, family/personal related	360	211	571	190	772	962	na	37
Wanted a better quality house (apartment)	633	58	691	309	1,065	1,374	na	8.5
Change from owner to renter OR renter to owner	68	92	160	1,330	46	1,376	na	57.2
Wanted lower rent or less expensive house to maintain	100	72	172	79	763	842	na	41.7
Other housing related reasons	263	90	353	103	614	716	na	25.6
Other	785	276	1,061	334	1,360	1,695	na	26

Notes: Recent movers are householders who changed their primary residences in the preceding year. Moving homeowners are current householders that moved in the previous 12 months from a home they owned or co-owned. White, black and Asian/other householders are non-Hispanic. Hispanic householders may be of any race. Asian/other includes Pacific Islanders, Aleuts and Native Americans. Married-couple households with one spouse absent are not included in the counts of married couples with and without children.

Source: JCHS tabulations of the 2001 American Housing Survey.

Table 22: Tenure Choices of Recent Movers

Single-Family Detached Resale Dwelling Units					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	173,002	48,036	18,228	0	239,266
1994	197,301	51,187	8,262	0	256,750
1995	171,458	43,882	8,758	0	224,098
1996	193,852	50,702	11,308	0	255,862
1997	211,533	55,377	14,992	0	281,902
1998	243,907	65,016	22,456	0	331,379
1999	260,219	68,089	27,840	0	356,148
2000	246,669	64,099	29,326	0	340,094
2001	229,725	60,050	29,764	409	319,948
2002	254,199	67,059	39,078	1,462	361,798
1993-2002	2,181,865	573,497	210,012	1,871	2,967,245

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 23: Single-Family Dwelling Resale Units

Single-Family Resale Area in 10^6 Sq.Ft.					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	269	96	37	0	402
1994	307	102	18	0	426
1995	264	86	19	0	370
1996	300	99	25	0	424
1997	327	108	32	0	467
1998	374	125	48	0	547
1999	393	129	59	0	580
2000	367	121	60	0	549
2001	337	110	58	1	507
2002	376	126	78	4	583
1993-2002	3,313	1,103	433	5	4,854

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 24: Single-Family Dwelling Resale Area

Condominium Resale Dwelling Units					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	23,448	18,468	3,365	0	45,281
1994	24,612	18,579	2,928	0	46,119
1995	23,019	16,225	2,293	0	41,537
1996	27,577	20,440	2,651	0	50,668
1997	32,344	23,855	4,116	0	60,315
1998	39,073	29,798	6,364	0	75,235
1999	43,666	33,216	6,819	0	83,701
2000	44,437	31,631	6,622	0	82,690
2001	41,231	29,042	6,333	103	76,709
2002	46,241	32,883	8,167	317	87,608
1993-2002	345,648	254,137	49,658	420	649,863

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 25: Condominium Resale Units

Condominium Resale Area in 10^6 Sq.Ft.					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	29	25	5	0	59
1994	31	26	4	0	61
1995	29	22	3	0	54
1996	34	28	4	0	66
1997	40	32	6	0	78
1998	48	40	9	0	97
1999	52	42	10	0	104
2000	52	39	9	0	100
2001	48	36	9	0	92
2002	54	41	11	0	106
1993-2002	416	330	71	1	817

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 26: Condominium Resale Area

Multifamily Resale Buildings					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	10,853	938	161	0	11,952
1994	13,029	1,119	244	0	14,392
1995	12,790	1,055	283	0	14,128
1996	15,149	1,096	329	0	16,574
1997	17,245	1,060	319	0	18,624
1998	19,553	1,320	421	0	21,294
1999	23,487	1,472	559	0	25,518
2000	23,333	1,539	357	0	25,229
2001	21,967	1,514	255	19	23,755
2002	23,942	1,740	346	18	26,046
1993-2002	181,348	12,853	3,274	37	197,512

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 27: Multifamily Resale Buildings

Multifamily Resale Area in 10^6 Sq.Ft.					
ReSale Yr	pre-1982	1982-1991	1992-2000	2001-current	Total
1993	48	15	1	0	64
1994	59	16	1	0	77
1995	57	12	1	0	69
1996	62	14	1	0	77
1997	78	12	1	0	91
1998	83	15	1	0	100
1999	102	16	2	0	121
2000	97	16	2	0	115
2001	82	13	1	0	97
2002	88	15	1	0	104
1993-2002	756	145	13	0	915

Source: California Residential Property Resale Data 1993-2002, DataQuick Information Systems

Table 28: Multifamily Resale Area

Nonresidential Floor Stock Area in 10^6 Sq.Ft. from 1975-2002													
Year	Sml-Off	Restaur.	Retail	FoodStr.	NfrgWhse	RefrgWhse	Elem	Univ	Hospital	Hotel	Miscell.	Lrg-Off	Total
1975	166	85	468	128	343	22	344	187	140	134	570	492	3,079
1976	173	88	482	131	356	23	351	193	145	136	584	501	3,163
1977	181	91	500	135	368	23	357	198	150	139	597	512	3,251
1978	191	94	520	140	383	24	361	201	153	141	610	523	3,343
1979	204	99	541	145	408	25	365	205	157	144	626	537	3,455
1980	217	102	564	151	430	26	367	207	160	146	642	557	3,568
1981	229	105	584	156	451	27	369	209	163	149	657	581	3,680
1982	239	107	599	160	467	27	370	212	168	153	669	610	3,781
1983	247	109	609	162	479	28	371	214	173	158	680	646	3,876
1984	256	111	619	165	488	28	373	216	177	165	691	677	3,966
1985	264	114	633	169	504	29	374	219	183	179	710	718	4,096
1986	274	117	655	174	527	30	376	221	191	193	736	764	4,257
1987	284	120	678	179	551	31	378	224	199	207	763	805	4,419
1988	292	123	703	186	577	32	381	228	209	220	791	838	4,580
1989	301	127	728	192	606	33	385	234	216	234	818	869	4,741
1990	309	130	751	197	632	33	390	238	225	240	846	902	4,895
1991	317	133	776	203	656	35	396	242	234	247	868	927	5,035
1992	322	135	793	208	669	36	402	245	240	251	885	941	5,127
1993	325	136	807	212	677	37	407	249	245	252	901	946	5,195
1994	328	137	817	214	681	38	413	252	250	252	912	949	5,243
1995	330	138	826	216	685	40	420	255	255	252	918	950	5,286
1996	332	139	834	218	690	40	424	258	258	252	928	952	5,325
1997	333	140	842	220	697	41	427	260	263	252	935	957	5,365
1998	335	141	852	222	704	41	430	262	266	253	945	964	5,416
1999	337	143	861	225	717	42	437	265	269	256	958	978	5,488
2000	339	145	873	227	732	44	441	269	273	260	976	999	5,577
2001	342	147	885	230	749	45	446	273	276	264	992	1,015	5,664
2002	348	150	897	233	762	45	453	277	280	269	1,008	1,033	5,756

* California Energy Commission, 2003 Forecast Data for Nonresidential Buildings.

Table 29: Nonresidential Floor Stock Area in 10^6 Sq.Ft. from 1975-2002

Commercial Resale Area in 10^6 Sq.Ft.					
ReSale Yr	pre-1978	1978-1991	1992-2000	2001-current	Total
1993	29	23	2	0	53
1994	35	19	2	0	56
1995	32	17	2	0	51
1996	29	15	2	0	46
1997	32	20	3	0	55
1998	40	23	6	0	69
1999	66	41	5	0	112
2000	42	27	3	0	72
2001	31	35	2	0	69
2002	35	17	2	0	54
1993-2002	372	237	29	0	637

Source: California Commercial Property Resale Data 1993-2002, DataQuick Information Systems

Table 30: Commercial Resale Area